Decision Rationale

Total Maximum Daily Load for
Fecal Coliform for Four Mile Run

I. Introduction

The Clean Water Act (CWA) requires a Total Maximum Daily Load (TMDL) be developed for those water bodies identified as impaired by a state where technology-based and other controls will not provide for attainment of water quality standards. A TMDL is a determination of the amount of a pollutant from point, nonpoint, and natural background sources, including a margin of safety (MOS), that may be discharged to a water quality-limited water body.

This document will set forth the Environmental Protection Agency's (EPA) rationale for approving the TMDL for fecal coliform for Four Mile Run. EPA's rationale is based on the determination that the TMDL meets the following eight regulatory conditions pursuant to 40 CFR §130.

1) The TMDL is designed to implement applicable water quality standards.
2) The TMDL includes a total allowable load as well as individual waste load allocations and load allocations.
3) The TMDL considers the impacts of background pollutant contributions.
4) The TMDL considers critical environmental conditions.
5) The TMDL considers seasonal environmental variations.
6) The TMDL includes a margin of safety.
7) There is reasonable assurance that the TMDL can be met.
8) The TMDL has been subject to public participation.

II. Background

Four Mile Run has a 19.7 square mile watershed located in Arlington County. The TMDL addresses a 7.5 mile stream stretch of Four Mile Run, beginning 9.0 miles upstream of its confluence with the Potomac River and terminating at its tidal/nontidal boundary approximately 1.5 miles upstream of its confluence with the Potomac River. The nontidal portion of the Four Mile Run watershed is 10,874 acres or 17 square miles in size. The watershed is extensively developed with developed lands making up 82% of the watershed. Open space areas (parks, golf courses, etc.) make up approximately 11% of the watershed area.

In response to Section 303(d) of the CWA, the Virginia Department of Environmental Quality

(VADEQ) listed this segment of Four Mile Run as being impaired by elevated levels of fecal coliform on Virginia's 1998 Section 303(d) list. Four Mile Run was listed for violations of Virginia's fecal coliform bacteria water quality standard associated with the primary contact usage. Fecal coliform is a bacterium which can be found within the intestinal tract of all warm blooded animals. Therefore, fecal coliform can be found in the fecal wastes of all warm blooded animals. Fecal coliform in itself is not a pathogenic organism. However, fecal coliform indicates the presence of fecal wastes and the potential for the existence of other pathogenic bacteria. The higher concentrations of fecal coliform indicate the elevated likelihood of increased pathogenic organisms.

EPA has been encouraging the states to use e-coli and enterococci as the indicator species instead of fecal coliform. A better correlation has been drawn between the concentrations of e-coli and enterococci, and the incidence of gastrointestinal illness. The Commonwealth plans on adopting the e-coli and enterococci standards in late 2002.

As Virginia designates all of its waters for primary contact, all waters must meet the current fecal coliform standard for primary contact. Virginia's standard applies to all streams designated as primary contact for all flows. Through the development of this and other similar TMDLs, it was discovered that natural conditions (wildlife contributions to the streams) could cause or contribute to violations of the fecal coliform standard. Thus, many of Virginia's TMDLs have called for some reduction in the amount of wildlife contributions to the affected streams. Bacterial source tracking (BST) data collected in association with this TMDL documented the impacts of wildlife to the stream. EPA believes that a significant reduction in wildlife is not practical and will not be necessary due to the implementation plan discussed below.

A phased implementation plan will be developed for all streams in which the TMDL calls for reductions in wildlife. In the first phase of the implementation, the Commonwealth will begin implementing the reductions (other than wildlife) called for in the TMDL. In Phase 2, which can occur concurrently to Phase 1, the Commonwealth will consider addressing its standards to accommodate this natural loading condition. The Commonwealth has indicated that during Phase 2, it may develop a Use Attainability Analysis (UAA) for streams with wildlife reductions which are not used for frequent bathing. Depending upon the result of the UAA, it is possible that these streams could be designated for secondary contact. The Commonwealth will also investigate incorporating a natural background condition for the bacteriological indicator.

After the completion of Phase 1 of the implementation plan, the Commonwealth will monitor the stream to determine if the wildlife reductions are actually necessary. In Phase 3, the Commonwealth will investigate the sampling data to determine if further load reductions are needed in order for these waters to attain standards. If the load reductions and/or the new application of standards allow the stream to attain standards, then no additional work is warranted. However, if standards are still not being attained after the implementation of Phases 1 and 2, further work and reductions will be warranted.

Four Mile Run VAN-A12R identified as watershed VAV-H28R, was given a high priority for TMDL development. Section 303(d) of the CWA and its implementing regulations require a TMDL to be developed for those waterbodies identified as impaired by the state where technology-based and other controls do not provide for the attainment of water quality standards. The TMDL submitted by Virginia is designed to determine the acceptable load of fecal coliform which can be delivered to Four Mile Run, as demonstrated by the Hydrologic Simulation Program Fortran (HSPF)[1], in order to ensure that the water quality standard is attained and maintained. HSPF is considered an appropriate model to analyze this watershed because of its dynamic ability to simulate both watershed loading and receiving water quality over a wide range of conditions.

The TMDL analysis allocates the application/deposition of fecal coliform to land based and instream sources. For land based sources, the HSPF model accounts for the buildup and washoff of pollutants from these areas. Buildup (accumulation) refers to all of the complex spectrum of dry-weather processes that deposit or remove (die-off) pollutants between storms.[2] Washoff is the removal of fecal coliform which occurs as a result of runoff associated with storm events. These two processes allow the HSPF model to determine the amount of fecal coliform from land based sources which is reaching the stream. Point sources and wastes deposited directly to the stream are treated as direct deposits in the model. These wastes do not need a transport mechanism to allow them to reach the stream. The allocation plan calls for the reduction in fecal coliform wastes delivered to Four Mile Run by fecal coliform deposits by dogs, humans, and wildlife to a wide range of land uses.

Table 1 - Summarizes the Specific Elements of the TMDL.

Segment	Parameter	TMDL	WLA (cfu/yr)**	LA (cfu/yr)	MOS (cfu/yr)*
Total	Fecal Coliform	1.03E+15	2.04E+13	9.61E+14	4.91E+13

* Virginia includes an explicit MOS by identifying the TMDL target as achieving the total fecal coliform water quality concentration of 190 cfu/100ml as opposed to the WQS of 200 cfu/ml. This can be viewed explicitly as a 5% MOS.

**The WLA is the summation of the loading from all current and future MS-4 facilities in the watershed.

EPA believes it is important to recognize the conceptual difference among the waste load allocation (WLA) values, load allocation (LA) values for sources modeled as direct deposition to stream segments, and LA values for flux sources of fecal coliform to land use categories. The WLA values and LA values represent amounts of fecal coliform which are actually deposited at the edge of

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[1]Bicknell, B.R., J.C. Imhoff, J.L. Little, and R.C. Johanson. 1993. Hydrologic Simulation Program-FORTRAN (HSPF): User's Manual for release 10.0. EPA 600/3-84-066. U.S. Environmental Protection Agency, Environmental Research Laboratory, Athens, GA.

[2]CH2MHILL, 2000. Fecal Coliform TMDL Development for Cedar, Hall, Byers, and Hutton Creeks Virginia,

stream. The WLA for this TMDL is not for a discrete point source but for diffuse and sporadically discharging entities, municipal separate stormwater systems (MS-4s). Therefore, the WLA is based on the loading to impervious areas within the drainage area of the MS-4s. The HSPF model, which considers landscape processes which affect fecal coliform runoff from land uses, determines the amount of fecal coliform which reaches the stream segments.

The United States Fish and Wildlife Service has been provided with copy of this TMDL.

III. Discussion of Regulatory Conditions

EPA finds that Virginia has provided sufficient information to meet all of the eight basic requirements for establishing a fecal coliform TMDL for Four Mile Run. EPA is therefore approving this TMDL. Our approval is outlined according to the regulatory requirements listed below.

1) The TMDL is designed to meet the applicable water quality standards.

Virginia has indicated that excessive levels of fecal coliform due to nonpoint sources (both wet weather and directly deposited nonpoint sources) have caused violations of the water quality standards and designated uses on Four Mile Run. The water quality criterion for fecal coliform is a geometric mean 200 cfu/100mL or an instantaneous standard of no more than 1,000 colony forming unites (cfu)/100ml. Two or more samples over a 30 day period are required for the geometric mean standard. Since the state rarely collects more than one sample over a thirty-day period, most of the samples are measured against the instantaneous standard.

Since 1990, over 700 samples have been taken from Four Mile Run and its tributaries. Almost half of these samples had fecal coliform concentrations above 1,000 cfu/100mL.[3] The study used a subset of this data for the TMDL on Four mile Run. A subset of these samples was used for the calibration of the TMDL. The TMDL report analyzes 146 samples collected by VADEQ, Arlington County Parks, and the Norther Virginia Regional Commission (NVRC) from 1991 through 2002. Based on the analysis, the highest fecal coliform mean concentrations were observed in the Summer and Fall seasons, while the highest violation rate was observed during the spring.

As with most of the Commonwealth's TMDLs, the TMDL for Four Mile Run utilized BST data to develop a better understand the sources of fecal coliform to the stream. The BST data was analyzed through the pulsed field gel electrophoresis technique. The analysis was performed on the e-coli bacteria found in the fecal matter. This analysis allowed for the determination of the sources of fecal coliform to the stream segment. For more information on the study, please refer to Appendix A of the

[3]NVRC, 2002. Fecal Coliform TMDL Development for Four Mile Run, Virginia. April 2002.

fecal coliform TMDL for Four Mile Run. According to the BST data, waterfowl were the largest contributors of fecal coliform to the watershed followed by humans and dogs. The BST data was used to assist the modelers in the development of a water quality model.

The HSPF model was used to determine the hydrology and water quality of Four Mile Run. The modelers manipulated the loadings to Four Mile Run through the HSPF model to determine support of the fecal coliform water quality criterion and primary contact use. The following discussion is intended to describe how controls on the loading of fecal coliform to Four Mile Creek will ensure that the criterion is attained.

The TMDL modelers determined the fecal coliform production rates within the watershed. Data used in the model was obtained on a wide array of items, including farm practices in the area, the amount and concentration of farm animals, point sources in the watershed, animal access to the stream, wildlife in the watershed, wildlife fecal production rates, land uses, weather, stream geometry, etc.. The model then combined all the data to determine the hydrology and water quality of the stream.

Calibration is the process of comparing modeled data to observed data and making appropriate adjustments to model parameters to minimize the error between observed and simulated events.[4] The TMDL model for Four Mile Run was calibrated to the United States Geological Survey gage at Shirlington. Flow data for this gage was collected from October 1998 through the present. The flow data was measured at 5 to 15 minute intervals. Since no data was available prior to October 1998, the calibration period was short and no validation (transferring the model to a different time period and running it without adjusting the hydrologic parameters to test its accuracy) of the calibration was conducted. The model simulated the observed data favorably; all of the calibration statistics were within the expected error range of the model. According to the flow duration curve, the simulation under estimated the lowest 0.5% of the flows.

With the success of the hydrologic calibration, water quality parameters were included into the model to measure fecal coliform concentrations. The water quality model results were manipulated to match the observed source loadings documented in the BST data. In order to manipulate the source loadings, the modeler had four parameters at their disposal to adjust. The four parameters were fecal production rates, fecal coliform concentrations in feces, source populations, and habitat in which the sources are located. The source population values were manipulated in order for the model to more accurately reflect observed conditions.

EPA believes that using HSPF to model and allocate fecal coliform will ensure that the designated uses and water quality standards will be attained and maintained for Four Mile Run.

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[4]Maptech, 2002. Fecal Coliform TMDL Development for Catoctin Creek Impairments, Virginia. April 23, 2002.

2) The TMDL includes a total allowable load as well as individual waste load allocations and load allocations.

Total Allowable Loads

Virginia indicates that the total allowable loading of fecal coliform is the sum of the loads allocated to land based precipitation driven nonpoint source areas (developed lands, parks and open spaces, golf courses, etc.) and point sources. Activities such as the deposition of fecal material from a dog or a goose on a land segment were considered fluxes to that land segment. The actual value for the total fecal load can be found in Table 1 of this document. The total allowable load is calculated on an annual basis due to the nature of HSPF model.

Waste Load Allocations

There were no traditionally permitted facilities within the watershed. However, there are two current MS-4 permits (Arlington and Fairfax counties) within the watershed. These entities can have hundreds of outfalls discharging stormwater runoff to the stream from their jurisdiction. Due to the nature of the source, storm events, these outfalls are expected to discharge sporadically. It should be mentioned that a sewer line may sometimes get crossed into a separate stormwater system inadvertently. Thus, discharging regardless of weather conditions.

The sporadic nature of the source and the diffuse nature of the discharge, makes it difficult to determine and measure compliance of such an entity with its TMDL generated WLA. Traditionally, MS-4 permits have not been written to include an effluent limit. These entities were given a set of best management practices (BMPs) to comply with instead of the numeric limit. The TMDL has allocated a WLA for all stormwater related flows, this value was determined based on the amount of fecal coliform being discharged to the stream from urban and residential impervious areas that were underlain by the MS-4 system in the model. The cities of Alexandria and Fall Church will receive MS-4 permits in the near future. The TMDL provided a lump sum loading for all (current and proposed) of the MS-4 systems within the watershed. The TMDL specifically designates a WLA but requires implementation and measurement through BMPs. The WLA for these facilities can be found in Table 1 of this report.

EPA regulations require that an approvable TMDL include individual WLAs for each point source. According to 40 CFR 122.44(d)(1)(vii)(B), "Effluent limits developed to protect a narrative water quality criterion, a numeric water quality criterion, or both, are consistent with assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA pursuant to 40 CFR 130.7." Furthermore, EPA has authority to object to the issuance of any National Pollutant Discharge Elimination System (NPDES) permit that is inconsistent with the WLAs established for that point source.

Load Allocations

According to Federal regulations at 40 CFR 130.2(g), LAs are best estimates of the loading, which may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting loading. Wherever possible, natural and nonpoint source loads should be distinguished.

In order to accurately simulate landscape processes and nonpoint source loadings, VADEQ used the HSPF model to represent the Four Mile Run watershed. The HSPF model is a comprehensive modeling system for the simulation of watershed hydrology, point and nonpoint loadings, and receiving water quality for conventional pollutants and toxicants[5]. HSPF uses precipitation data for continuous and storm event simulation to determine total fecal loading to Four Mile Run from the various land uses. The total land loading of fecal coliform is the deposition of fecal material on those land surfaces from pets, wildlife and humans. There were no agricultural practices occurring within the watershed. Please note that all of the values in Table 3 are given in terms of cfu to the land surface. The amount of waste from these sources reaching the stream is lower. Significant reductions were called for all sources of fecal coliform to these land uses, including humans, waterfowl, dogs, racoons, and other wildlife. At least a 95% reduction in loading was needed from each source.

Table 3 - LA for the Land Application of Fecal Coliform

Land Use	Allocated Loading from Impervious and Pervious Land Segments
Open Space/Parks	1.08E+14
Highway	7.11E+12
Medium-High Density Mixed	2.83E+13
Medium-High Density Industry	6.40E+12
Public Lands/Golf Course	9.30E+13
High Density Residential	1.16E+13
Medium Density Residential	3.94E+14
Medium-High Density Residential	1.08E+14

[5] Supra, footnote 2.

Medium-High Density Commercial	1.01E+13
Low-Medium Density Residential	1.08E+14
Land Use	Allocated Loading from Impervious and Pervious Land Segments
Low Density Commercial	5.65E+13
Low Density Industrial	3.67E+12
Low Density Mixed Use	2.15E+13
Federal	2.45E+13
Total	9.81E+14

3) The TMDL considers the impacts of background pollution.

A background concentration was set by determining the wildlife loading to each land segment.

4) The TMDL considers critical environmental conditions.

According to the EPA regulation 40 CFR 130.7 (c)(1), TMDLs are required to take into account critical conditions for stream flow, loading, and water quality parameters. The intent of this requirement is to ensure that the water quality of Four Mile Run is protected during times when it is most vulnerable.

Critical conditions are important because they describe the factors that combine to cause a violation of water quality standards and will help in identifying the actions that may have to be undertaken to meet water quality standards[6]. Critical conditions are a combination of environmental factors (e.g., flow, temperature, etc.), which have an acceptably low frequency of occurrence. In specifying critical conditions in the waterbody, an attempt is made to use a reasonable "worst-case" scenario condition. For example, stream analysis often uses a low-flow (7Q10) design condition because the ability of the waterbody to assimilate pollutants without exhibiting adverse impacts is at a minimum. These critical conditions ensure that water quality standards will be met for other than worst case scenarios.

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[6]EPA memorandum regarding EPA Actions to Support High Quality TMDLs from Robert H. Wayland III, Director, Office of Wetlands, Oceans, and Watersheds to the Regional Management Division Directors, August 9, 1999.

The sources of bacteria for these stream segments were a mixture of dry and wet weather driven sources. Therefore, the critical condition for Four Mile Run was represented as a typical hydrologic year. The TMDL was modeled to insure the attainment of the standard through a typical hydrologic year.

5) The TMDLs consider seasonal environmental variations.

Seasonal variations involve changes in stream flow as a result of hydrologic and climatological patterns. In the continental United States, seasonally high flows normally occur in early spring from snow melt and spring rain, while seasonally low flows typically occur during the warmer summer and early fall drought periods. Consistent with our discussion regarding critical conditions, the HSPF model and TMDL analysis effectively considered seasonal environmental variations. The model also accounted for the seasonal variation in loading. Fecal coliform loads changed for many of the sources depending on the time of the year. For example, cattle spent more time in the stream in the summer and animals were confined for longer periods of time in the winter.

6) The TMDLs include a margin of safety.

This requirement is intended to add a level of safety to the modeling process to account for any uncertainty. The MOS may be implicit, built into the modeling process by using conservative modeling assumptions, or explicit, taken as a percentage of the WLA, LA, or TMDL.

Virginia includes an explicit MOS by establishing the TMDL target water quality concentration for fecal coliform at 190 cfu/ 100mL, which is more stringent than Virginia's water quality standard of 200 cfu/100 mL. This would be considered an explicit 5% MOS.

7) There is a reasonable assurance that the TMDL can be met.

EPA requires that there be a reasonable assurance that the TMDL can be implemented. WLAs will be implemented through the NPDES permit process. According to 40 CFR 122.44(d)(1)(vii)(B), the effluent limitations for an NPDES permit must be consistent with the assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA. Furthermore, EPA has authority to object to issuance of an NPDES permit that is inconsistent with WLAs established for that point source.

Nonpoint source controls to achieve LAs can be implemented through a number of existing programs such as Section 319 of the CWA, commonly referred to as the Nonpoint Source Program. Additionally, Virginia's Unified Watershed Assessment, an element of the Clean Water Action Plan, could provide assistance in implementing this TMDL.

The TMDL in its current form is designed to meet the applicable water quality standards.

However, the reductions needed to attain these standards are extreme. The Commonwealth intends to implement these TMDLs through BMPs. The implementation of these practices will occur in stages. This is will allow the Commonwealth to monitor the benefits of the BMPs and determine which practices have the greatest impacts on water quality. It will also provide a mechanism for developing public support and checking the accuracy of the model.

To address the wildlife issue that was previously mentioned, the Commonwealth believes that it may be appropriate to modify its current standards to address the problems associated with wildlife loadings.

8) The TMDLs have been subject to public participation.

Two public meetings were held to discuss TMDL development on Four Mile Run. Both public meetings were public noticed in the *Virginia Register* and opened to at least a 30 day comment period. The first meeting was held on June 14, 2001 in Alexandria, VA. Approximately 20 people attended this initial meeting on the TMDL. Four written comments were received during the comment period. The second meeting was held in Alexandria, VA on March 25, 2002.